

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:

Parker et al.

Examiner:

Unknown

Serial No.:

10/077036

Group Art Unit:

2881

Filed:

2/15/02

Docket No.:

SJO919990205US1

501.314US01

Title:

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METHOD AND APPARATUS FOR COMPENSATING WAVEFORMS,

SPECTRA, AND PROFILES DERIVED THEREFROM FOR EFFECTS OF

DRIFT

CERTIFICATE UNDER 37 C.F.R. 1.8: The undersigned hereby certifies that this Transmittal Letter and the paper, as described herein, are being deposited in the United States Postal Service, as first class mail, with sufficient postage, in an envelope addressed to: Assistant Commissioner for Patents, Washington, D.C. 20231 on April 23, 2002

David W. Lynch

Name

Signature

SUBMISSION OF FORMAL DRAWINGS

Assistant Commissioner for Patents Washington, D.C. 20231

Dear Sir:

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PATENT TRADEMARK OFFICE

Enclosed herewith are 26 sheet(s) of formal drawings for the above-referenced patent application in response to the communication dated April 1, 2002.

Respectfully submitted,

Altera Law Group, LLC 6500 City West Parkway

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Date: April 23, 2002

By:

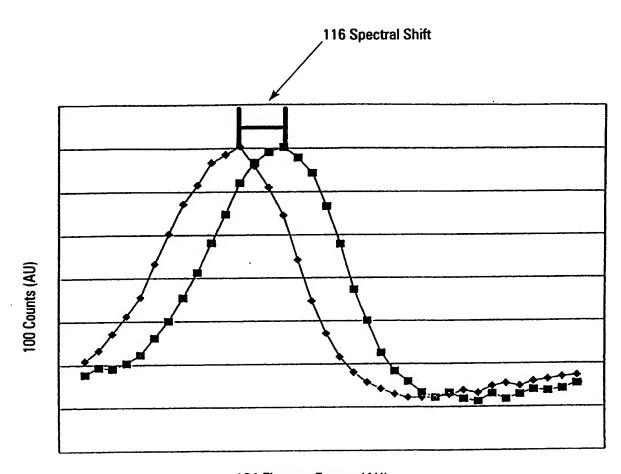
David W. Lynch

Reg. No. 36,204

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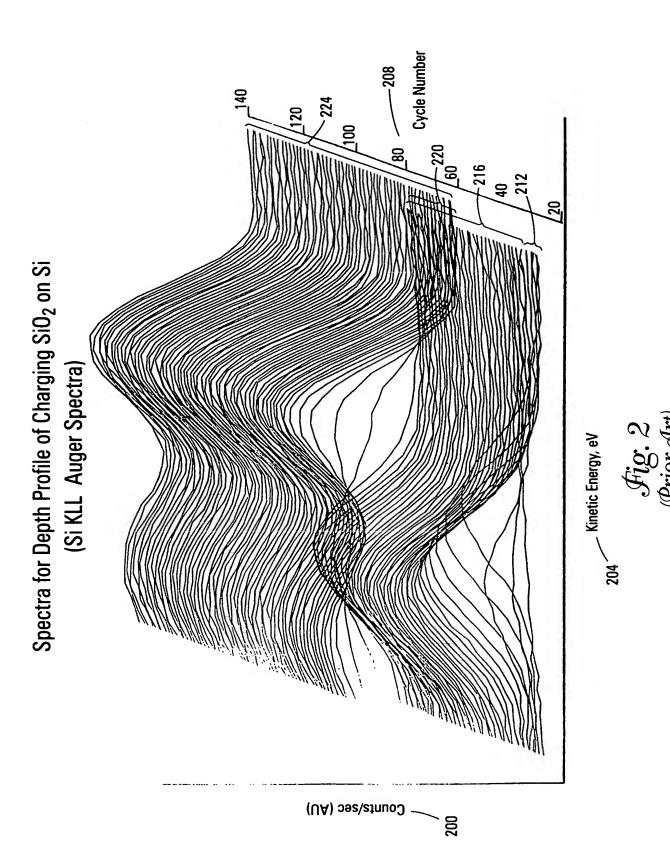
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> Fig. 1 (PriorArt)



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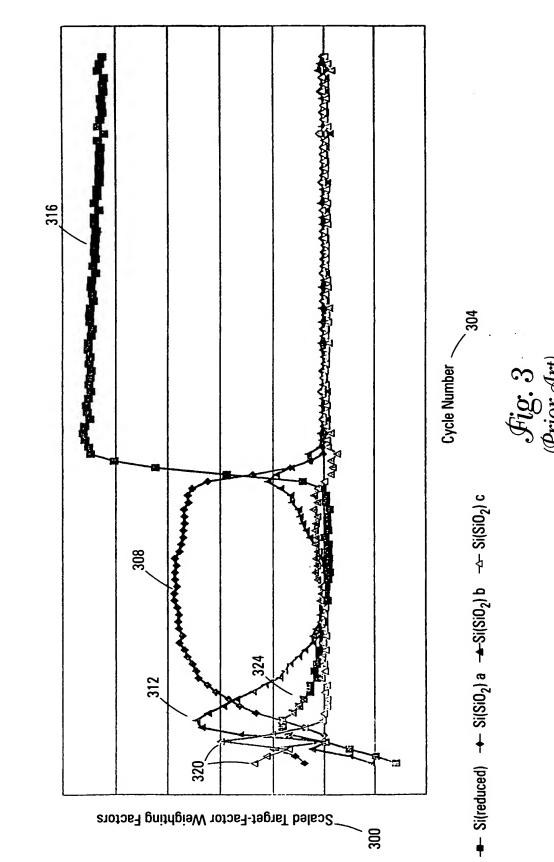


Fig. 4 Fig. 4a Fig. 4b

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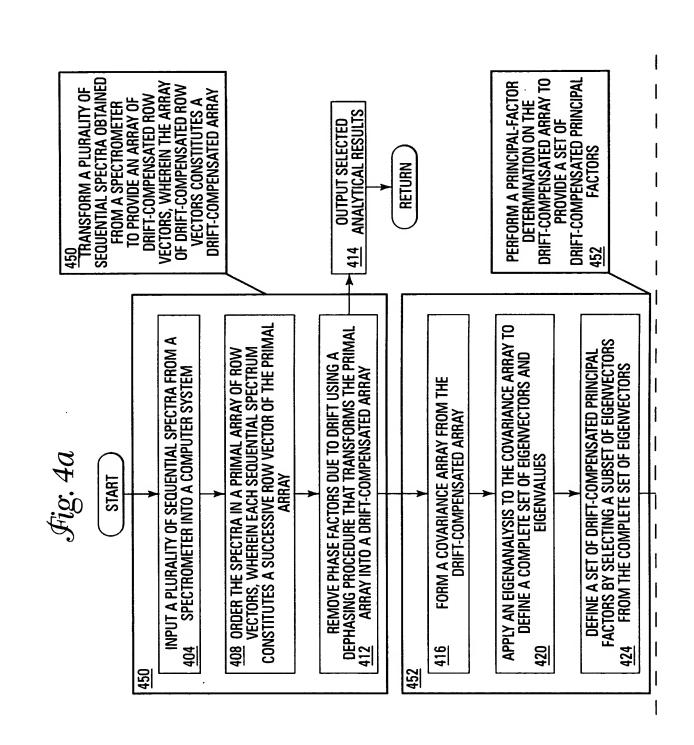
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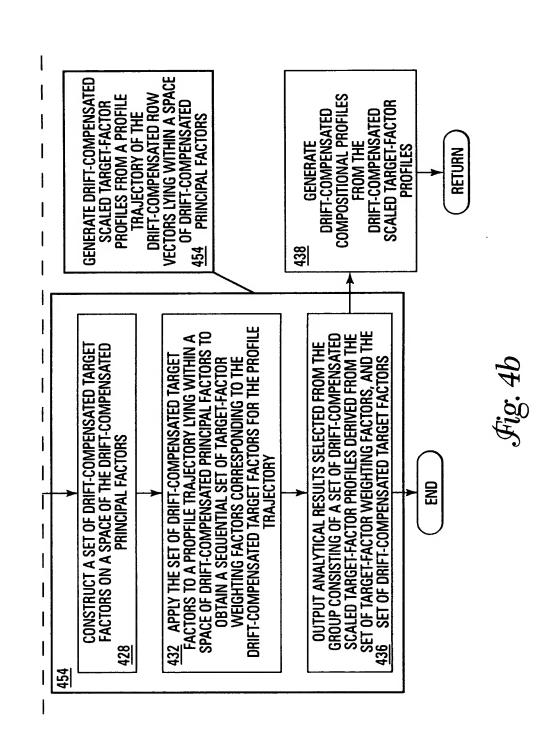
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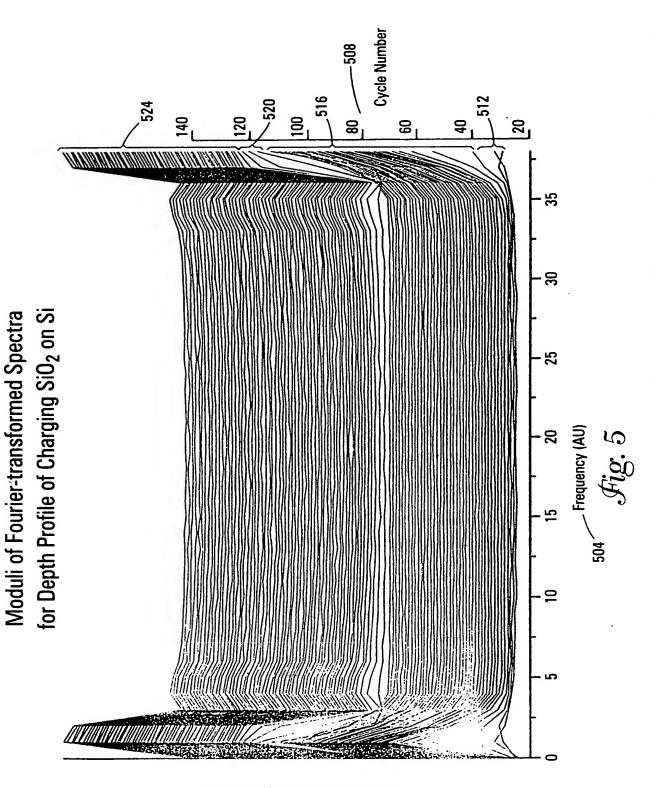




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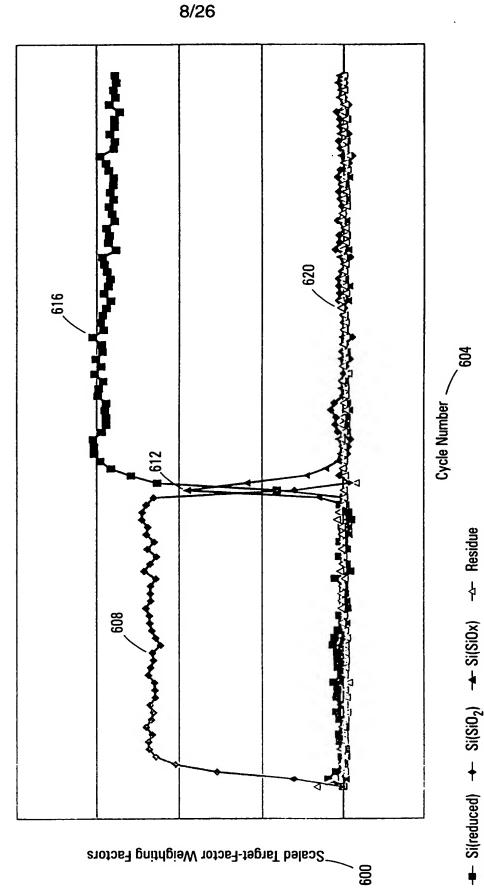
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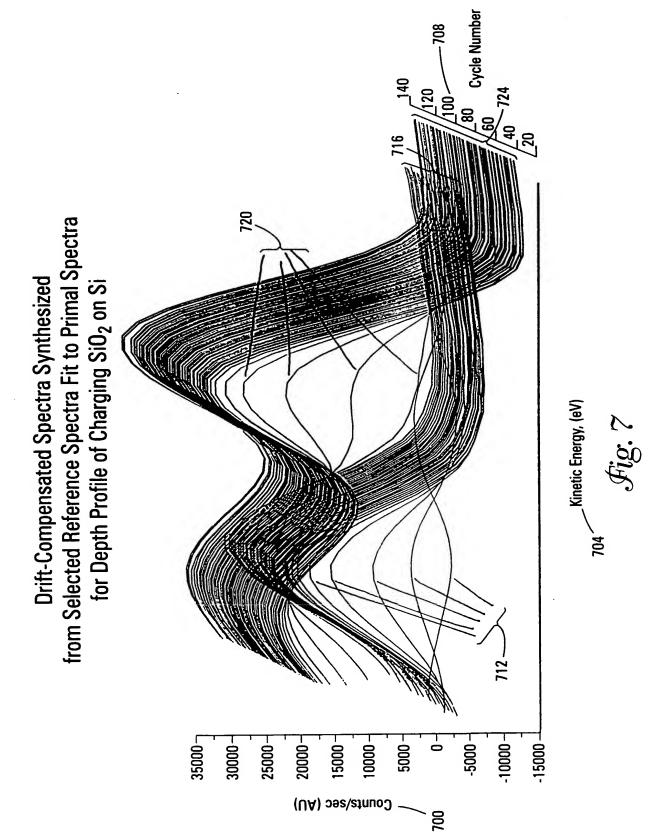
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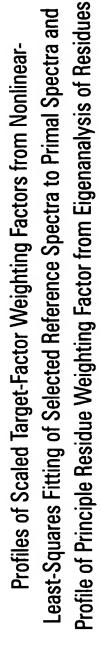
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Profiles of Scaled Target-Factor Weighting Factors from Factor Analysis of Moduli of Fast-Fourier-Transformed Auger Spectra from Charging SiO₂ on Si Substrate





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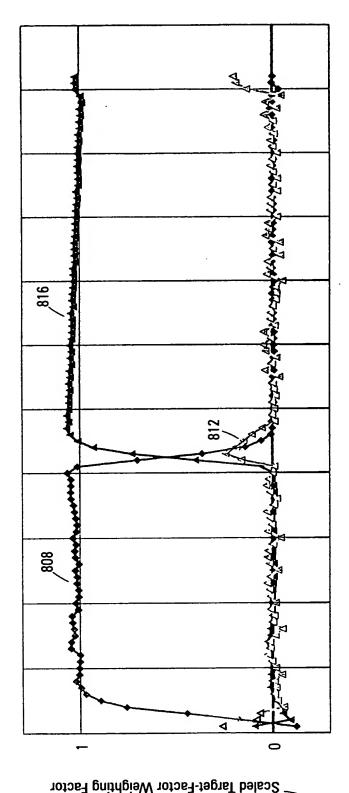


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-A- Principle-Residue Weighting Factor

← Si(SiO₂) ←-Si(reduced)

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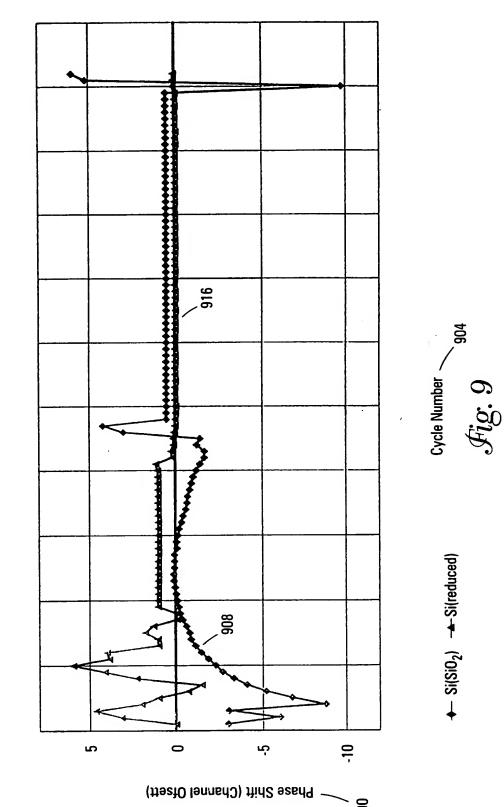
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Cycle Number

Profiles of Phase Factors for Selected Reference

Spectra Obtained from Fitting to Primal Spectra





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REMOVE PHASE FACTORS DUE TO DRIFT USING A DEPHASING PROCEDURE THAT TRANSFORMS THE PRIMAL ARRAY INTO A **DRIFT-COMPENSATED ARRAY** 412

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412

APPLY A FOURIER TRANSFORM TO THE SPECTRA IN THE PRIMAL ARRAY OF ROW VECTORS FORMING AN ARRAY OF FOURIER-TRANSFORMED ROW VECTORS 1010

MULTIPLY EACH FOURIER-TRANSFORMED ROW VECTOR BY A COMPLEX CONJUGATE OF EACH FOURIER-TRANSFORMED **ROW VECTOR TO FORM A SQUARED MODULI VECTOR** 1020THEREBY REMOVING PHASE FACTORS DUE TO DRIFT

TAKE THE SQUARE ROOT OF EACH ELEMENT OF THE SQUARED MODULI VECTOR TO CREATE A CORRESPONDING **MODULI VECTOR** 1030

FORM A DRIFT-COMPENSATED ARRAY OF MODULI VECTORS BY SUCCESSIVELY SEQUENCING THE MODULI VECTORS AS SUCCESSIVE DRIFT-COMPENSATED ROW VECTORS IN A DRIFT-COMPENSATED ARRAY, WHEREIN THE MODULI **VECTORS CONSTITUTE MODULI OF FOURIER-TRANSFORMED SPECTRA** 1040

Fig. 10

REMOVE PHASE FACTORS DUE TO DRIFT USING A DEPHASING PROCEDURE THAT TRANSFORMS THE PRIMAL ARRAY INTO A DRIFT-COMPENSATED ARRAY 412

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APPLY A FITTING PROCEDURE TO EACH SPECTRUM IN THE PRIMAL ARRAY USING SELECTED REFERENCE SPECTRA 1110

CALCULATE THROUGH THE FITTING PROCEDURE A CORRESPONDING REFERENCE WEIGHTING FACTOR FOR **EACH REFERENCE SPECTRUM CORRESPONDING TO EACH** SPECTRUM IN THE PRIMAL ARRAY

REMOVE THE PHASE FACTOR DUE TO DRIFT FROM EACH SPECTRUM IN THE PRIMAL ARRAY BY SYNTHESIZING A CORRESPONDING DRIFT-COMPENSATED SPECTRUM GIVEN BY THE SUM OF EACH SELECTED REFERENCE SPECTRUM MULTIPLIED BY THE CORRESPONDING REFERENCE **WEIGHTING FACTOR** 1130

FORM A DRIFT-COMPENSATED ARRAY BY SUCCESSIVELY SEQUENCING THE DRIFT-COMPENSATED SPECTRA AS SUCCESSIVE DRIFT-COMPENSATED ROW VECTORS IN THE **DRIFT-COMPENSATED ARRAY**

Fig. 11

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PERFORM A PRINCIPAL-FACTOR **DETERMINATION ON THE** DRIFT-COMPENSATED ARRAY TO PROVIDE A SET OF DRIFT-COMPENSATED PRINCIPAL **FACTORS** 452 1200 452 SELECT A SET OF INITIAL FACTORS FROM THE SET OF DRIFT-COMPENSATED ROW VECTORS OF THE **DRIFT-COMPENSATED ARRAY** 1210 PERFORM A LINEAR-LEAST-SQUARES DECOMPOSITION WITH THE SET UF INITIAL FACTORS ON THE DRIFT-COMPENSATED ROW VECTORS IN THE DRIFT-COMPENSATED ARRAY TO PROVIDE A SET OF **RESIDUE FACTORS** 1220 PERFORM A GRAM-SCHMIDT ORTHONORMALIZATION ON THE COMBINED SET OF INITIAL FACTORS AND RESIDUE FACTORS TO PROVIDE DRIFT-COMPENSATED PRINCIPAL FACTORS 1230

Fig. 12

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CONSTRUCT A SET OF DRIFT-COMPENSATED TARGET FACTORS ON A SPACE OF THE DRIFT-COMPENSATED PRINCIPAL **FACTORS** 428

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GENERATE A PROFILE TRAJECTORY ON A 3-DIMENSIONAL PROJECTION OF A 4-DIMENSIONAL SPACE OF A SET OF FIRST-FOUR, DRIFT-COMPENSATED PRINCIPAL FACTORS ALONG WITH A REFERENCE TETRAHEDRON THE VERTICES OF WHICH REPRESENT EACH OF THE FIRST-FOUR, **DRIFT-COMPENSATED PRINCIPAL FACTORS** 1310

ENCLOSE THE PROFILE TRAJECTORY WITHIN AN ENCLOSING TETRAHEDRON WITH VERTICES CENTERED ON END-POINTS AND IN PROXIMITY TO TURNING POINTS OF THE PROFILE TRAJECTORY, AND WITH FACES LYING **ESSENTIALLY TANGENT TO PORTIONS OF THE PROFILE** 1320 TRAJECTORY

CALCULATE THE DRIFT-COMPENSATED TARGET FACTORS FROM THE NORMED COORDINATES OF THE VERTICES OF THE ENCLOSING TETRAHEDRON IN TERMS OF THE DRIFT-COMPENSATED PRINCIPAL FACTORS 1330

Fig. 13

Parker et al. G THE EFFECTS OF CHARGING FROM AUGE CTRON SPECTROSCOPY AND ESCA COMPOSITION DEPTH PROFILES SJ0919990205US1 / 501.314US01

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GENERATE A PROFILE TRAJECTORY ON A **3-DIMENSIONAL PROJECTION OF** A 4-DIMENSIONAL SPACE OF A FIRST-FOUR, **DRIFT-COMPENSATED PRINCIPAL FACTORS ALONG WITH A** REFERENCE TETRAHEDRON THE VERTICES OF WHICH REPRESENT EACH OF THE FIRST-FOUR, **DRIFT-COMPENSATED PRINCIPAL FACTORS** 1310

1400

1310

1410 CALCULATE 4-SPACE COORDINATES OF A PROFILE TRAJECTORY OF DRIFT-COMPENSATED TARGET-FACTOR PROFILES ON A 4-DIMENSIONAL SPACE TO PRODUCE FOUR COORDINATES FOR EACH POINT IN THE PROFILE TRAJECTORY, ONE COORDINATE FOR EACH OF THE FIRST-FOUR, DRIFT-COMPENSATED PRINCIPAL FACTORS

REDUCE THE DIMENSIONALITY OF THE COORDINATES OF THE PROFILE TRAJECTORY BY DIVIDING EACH COORDINATE BY A SUM OF ALL FOUR 4-SPACE COORDINATES TO PRODUCE NORMED COORDINATES FOR THE PROFILE 1420 **TRAJECTORY**

PLOT THE NORMED COORDINATES FOR THE PROFILE TRAJECTORY IN A 3-DIMENSIONAL SPACE THE COORDINATES AXES OF WHICH ARE EDGES OF A REFERENCE TETRAHEDRON, THE VERTICES OF WHICH CORRESPOND TO UNIT VALUES FOR EACH OF THE FIRST-FOUR, DRIFT-COMPENSATED PRINCIPAL FACTORS IN A MANNER ANALOGOUS TO PLOTTING OF COORDINATES ON A QUATERNARY PHASE DIAGRAM 1430

Fig. 14

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ENCLOSE THE PROFILE TRAJECTORY WITHIN AN **ENCLOSING TETRAHEDRON WITH VERTICES CENTERED ON** END-POINTS AND IN PROXIMITY TO TURNING POINTS OF THE PROFILE TRAJECTORY, AND WITH **FACES LYING ESSENTIALLY** TANGENT TO PORTIONS OF THE PROFILE TRAJECTORY; AND, CALCULATE THE DRIFT-COMPENSATED TARGET FACTORS FROM THE NORMED **COORDINATES OF THE VERTICES** OF THE ENCLOSING TETRAHEDRON IN TERMS OF THE DRIFT-COMPENSATED PRINCIPAL 320 & 1330 FACTORS

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PLACE VERTICES OF AN ENCLOSING TETRAHEDRON AT LOCI OF HEAVY POINT CONCENTRATIONS OF A PROFILE **TRAJECTORY** 1510

ADJUST THE EDGES OF AN ENCLOSING TETRAHEDRON TO LIE ALONG ESSENTIALLY STRAIGHT LINE 1520 **SEGMENTS**

PLACE REMAINING VERTICES OF AN ENCLOSING TETRAHEDRON SO AS TO LIE NEAR THE TURNING POINTS OF THE PROFILE TRAJECTORY 1530

ADJUST THE FACES OF THE ENCLOSING TETRAHEDRON TO LIE ALONG CURVED SEGMENTS JOINING A TURNING POINT AND ESSENTIALLY STRAIGHT LINE SEGMENTS OF THE **PROFILE TRAJECTORY** 1540

Fig. 15

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Fig. 16a

Fig. 16b

Fig. 16

Fig. 16a

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MOVING ITS VERTICES TO ENCLOSE THE PROFILE TRAJECTORY USING SOFTWARE BASED ON METHODS WELL DRAG THE VERTICES OF THE ENCLOSING TETRAHEDRON TO THE LOCI OF HEAVY POINT CONCENTRATIONS IN THE TETRAHEDRON TO POSITION THEM IN THE VICINITY OF ANY TURNING POINTS IN THE PROFILE TRAJECTORY SO THAT ON ÓR IN CLOSE PROXIMITY TO ANY CURVED PORTIONS OF ESSENTIALLY SPANNING THE SPACE OF THE PROJECTIONS OF THE FIRST-FOUR, DRIFT-COMPENSATED PRINCIPAL AND, PLACE THE FACES OF THE ENCLOSING TETRAHEDRON ESSENTIALLY STRAIGHT LINE SEGMENTS LIE IN CLOSE PROXIMITY TO EDGES OF THE ENCLOSING TETRAHEDRON GENERATE AN ENCLOSING TETRAHEDRON BY STARTING TRAJECTORY OF THE PROJECTIONS OF A SEQUENCE OF WITH A COPY OF THE REFERENCE TETRAHEDRON AND KNOWN IN THE ART OF THE DISPLAY OF GRAPHICALLY DRAG ANY REMAINING VERTICES OF THE ENCLOSING **ROW VECTORS AND THE REFERENCE TETRAHEDRON** THE TRAJECTORY THAT CONNECT TURNING POINTS 610 DISPLAY ON A COMPUTER MONITOR THE PROFILE GENERATED COMPUTER OBJECTS PROFILE TRAJECTORY **FACTORS** 1620 1640 APPLY MINOR ADJUSTMENTS TO THE LOCATION OF THE VERTICES OF THE ENCLOSING TETRAHEDRON TO ENCLOSE THE SUBSPACE OF THE PROFILE TRAJECTORY WITH A MINIMAL VOLUME THAT BEST FITS THE DRIFT CORRECTED DATA REPRESENTED BY THE PROFILE TRAJECTORY, PROVIDING AN ENCLOSING TETRAHEDRON, THE VERTICES OF WHICH CORRESPOND WITH THE DRIFT-COMPENSATED TARGET FACTORS OF THE ANALYSIS

DEFINE THE NORMED COORDINATES OF THE VERTICES OF THE ENCLOSING TETRAHEDRON RELATIVE TO THE REFERENCE TETRAHEDRON AS THE ENCLOSING-VERTEX WEIGHTING FACTORS USED TO OBTAIN THE DRIFT-COMPENSATED TARGET FACTORS FROM THE NORMALIZED FIRST-FOUR, DRIFT-COMPENSATED PRINCIPAL

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OBTAIN THE VECTORS GIVING THE DRIFT-COMPENSATED
TARGET FACTORS FOR EACH VERTEX OF THE ENCLOSING
TETRAHEDRON BY SUMMING THE PRODUCTS OF EACH
ENCLOSING-VERTEX WEIGHTING FACTOR WITH THE VECTOR
GIVING THE NORMALIZED FIRST-FOUR,
DRIFT-COMPENSATED PRINCIPAL FACTOR THAT
CORRESPONDS TO EACH VERTEX OF THE REFERENCE
1670

Fig. 16b

րթող, գնամբ տասարդ աստեր բնակ քուղի բանձա բանա բանա բանադրա բանադր երեքուր հի նե՛ են ար՛ տ՛ են եր որոք՝ հրատու Ո՛ և ենտում են հասանի ձև երենակ և հետոն հետոն չի՛՛ չի՝ Կապեն ուսեն հետոն՝ ենտոն հետոն հետոն

Fig. 17	Fig. 17a	Fig. 17b

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OUTPUT ANALYTICAL RESULTS DRIFT-COMPENSATED SCALED DRIFT-COMPENSATED TARGET SELECTED FROM THE GROUP **FARGET-FACTOR WEIGHTING DERIVED FROM THE SET OF** FACTORS, AND THE SET OF TARGET-FACTOR PROFILES **CONSISTING OF A SET OF**

> **OBTAIN THE SET OF DRIFT-COMPENSATED TARGET-FACTOR** DRIFT-COMPENSATED TARGET FACTORS TO THE PROFILE MANNER ANALOGOUS TO FINDING COORDINATES OF A FACTORS, FROM THE ENCLOSING TETRAHEDRON IN A TRAJECTORY, I.E. THE TARGET-FACTOR WEIGHTING **COORDINATES OF EACH POINT ON THE PROFILE** TRAJECTORY BY ASCERTAINING THE NORMED POINT ON A QUARTERNARY PHASE DIAGRAM PROFILE VALUES BY APPLYING THE SET OF

436

FACTORS BY THE TARGET-FACTOR WEIGHTING FACTORS CORRESPONDING TO THE DRIFT-COMPENSATED TARGET COMPOSE A REFERENCE VECTOR BY SUMMING THE PRODUCTS FROMED BY MULTIPLYING THE VECTORS FOR EACH POINT ON THE PROFILE TRAJECTORY

VECTOR TO OPTIMALLY MATCH THE CORRESPONDING ROW 730VECTOR COMPENSATED FOR THE EFFECTS OF DRIFT SCALE THE AMPLITUDE OF THE RESULTING REFERENCE

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TARGET-FACTOR WEIGHTING FACTORS, TO OBTAIN THE PRODUCT OF EACH INDIVIDUAL TARGET-FACTOR WEIGHTING SCALAR VALUE THAT OPTIMALLY MATCHES THE REFERENCE DRIFT-COMPENSATED TARGET FACTOR THAT CONTRIBUTES TO A PARTICULAR ROW VECTOR REPRESENTED BY A POINT DETERMINE A CORRESPONDING SCALING FACTOR AS THE **OUTPUT OR DISPLAY THE PROFILES AS A SET OF CURVES** COORDINATES OF THE PROFILE TRAJECTORY, I.E. THE CORRESPONDING TO THE SCALED TARGET-FACTOR FACTOR WITH THE SCALING FACTOR, I.E. SCALED TARGET-FACTOR WEIGHTING FACTORS 1750 MULTIPLY THIS SCALING FACTOR BY THE NORMED WEIGHTING FACTORS, I.E. DRIFT-COMPENSATED TARGET-FACTOR PROFILE VALUES, FOR EACH ON THE PROFILE TRAJECTORY **VECTOR TO THE ROW VECTOR** 1760 1740

Fig. 17b

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DEFINE A SET OF DRIFT-COMPENSATED SCALED TARGET-FACTOR PROFILE VALUES AS THE SET OF SCALED TARGET-FACTOR WEIGHTING FACTORS 1810

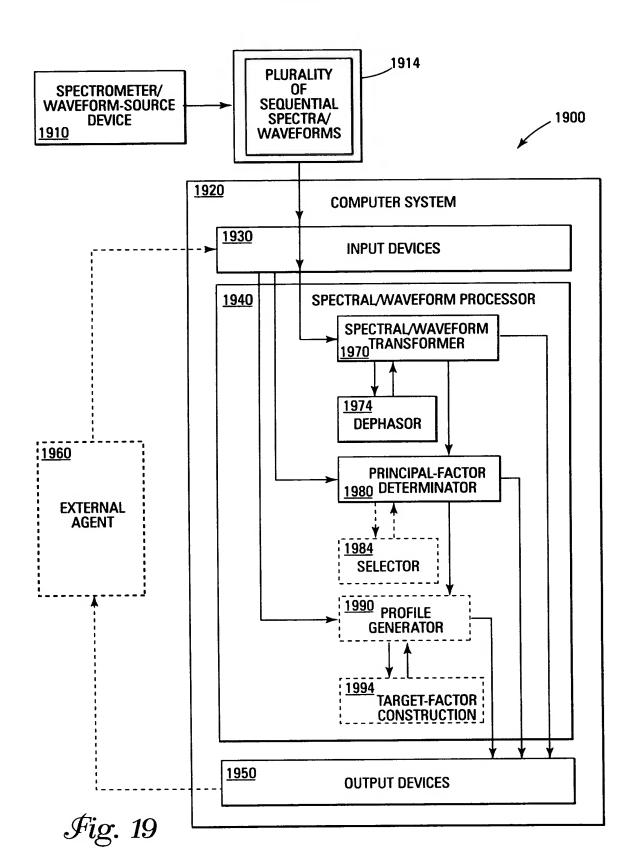
DIVIDE EACH DRIFT-COMPENSATED SCALED TARGET-FACTOR PROFILE VALUE BY A PROFILE SENSITIVITY FACTOR FOR EACH CONSTITUENT CORRESPONDING TO THE TARGET FACTOR TO PROVIDE A SENSITIVITY-SCALED 1820 **TARGET-FACTOR PROFILE VALUE**

NORMALIZE THE SENSITIVITY-SCALED TARGET-FACTOR PROFILE VALUE BY DIVIDING EACH SENSITIVITY-SCALED TARGET-FACTOR PROFILE VALUE FOR A GIVEN CYCLE NUMBER BY THE SUM OF ALL THE SENSITIVITY-SCALED TARGET-FACTOR PROFILE VALUES FOR THE GIVEN CYCLE NUMBER TO PROVIDE DRIFT-COMPENSATED COMPOSITIONAL PROFILE VALUES AT THE GIVE CYCLE **NUMBER** 1830

OUTPUT THE DRIFT-COMPENSATED COMPOSITIONAL PROFILE VALUES AS A SET OF DRIFT-COMPENSATED **COMPOSITIONAL PROFILES** 1840

Fig. 18

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